**Course Title: Calculus and Linear Algebra**
**Course Code: MATH 101**
**Credit Hours: 3**

**Course Description:**
The course explains the fundamental ideas of Calculus and Linear Algebra and shows how they are applied in different disciplines. The objectives of this course are just to provide enough mathematical facts to cope with a wide variety of problems in Engineering and Science.

**Course Contents:**

**Unit 1: Functions, Limits and Continuity**
Function; Domain and Range of a function, Piecewise-defined functions, Increasing and Decreasing functions, Even and Odd functions, Symmetry, Combining functions: Sums, Differences, Products and Quotients of Functions, Composite functions, Shifting and Scaling a graph of a function, $\varepsilon$-$\delta$ Definition of Limit, One sided limits, Existence of limit at a given point, Limits of exponential and Logarithmic functions, Limits involving infinity, Continuity of a function at an interior point and end points of its domain and Types of discontinuities

**Unit 2: Differentiation**
Differentiability of a function, Proof of the theorem relating differentiability and continuity of a function with some counter examples, Differentiation of Logarithmic, Exponential, Hyperbolic, Inverse Trigonometric and Inverse Hyperbolic functions, Tangent and Normal lines, Angle between two curves, related rates, Linearization and Differentials

**Unit 3: Applications of Derivatives**
Absolute Extreme Values and Local Extreme Values, Rolle's Theorem and Mean Value Theorem (Geometrical interpretations and their verifications), Asymptotes of graphs: Horizontal, Vertical and Oblique asymptotes, Relative rate of growth, Monotonic Functions and The First Derivative Test for Local Extrema, Concavity, The Second Derivative Test for Local Extrema and Curve Sketching, Indeterminate Forms: L' Hôpital's rule

**Unit 4: Integration**
The fundamental theorem of integral calculus Part 1 and Part 2 (Statements and their applications), Average value of a function, Integration by parts, Substitution methods, Integrals involving $a^2 + x^2$ , $\sqrt{a^2 - x^2}$, $\sqrt{a^2 + x^2}$ , $\sqrt{x^2 - a^2}$, $ax^2 + bx + c$ , Integration of rational functions by partial fractions , Improper integrals of Type I and Type II

**Unit 5: Applications of Definite Integrals**
Area between curves, Volume of solid of revolution (Disk and Washer Method), Length of a plane curve, Surface area of solid of revolution

**Unit 6: Sequence and Infinite Series**
Sequence of numbers, Convergence and Divergence of the sequence, Sandwich Theorem, Infinite series, Partial sums, Infinite geometric series, The *n*th Term Test of a divergent series, Integral Test, Ratio Test and Root Test for the series of non-negative terms

**Unit 7: System of Linear Equations**

System of Linear Equations: Matrix Notation, Elementary Row Operations, Homogeneous and Non-homogeneous Linear Systems, Solving a Linear System, Row reduction and Echelon form: Pivot Positions, The Row Reduction Algorithm, Uniquely and parametrically represented solutions

**Unit 8: Vector Space and Linear Transformations**

Vector Equations: Vectors in $R^2$ and $R^3$, Linear Combination of vectors: A Geometric Description of Span $\{v\}$ and Span $\{u, v\}$ , Linear Dependence, Independence, Introduction to Linear Transformations ,Subspace of $R^n$ (n = 2, 3), Column Space and Null Space of a matrix, Basis, Dimension and Rank

**Unit 9: Eigenvalues and Eigenvectors**

Characteristic Equation, Eigenvalues and Eigenvectors, Eigenspace

**References:**


1. G. B. Thomas, R. L. Finney , *Thomas' Calculus*, Narosa Publishing House, New Delhi
2. David C. Lay, *Linear Algebra and Its Applications*, Pearson, India
3. James Stewart, *Calculus - Early Transcendentals*, Thomson Brooks/Cole
4. D. T. Finkbeiner, *Introduction to Matrices and Linear Transformations*, 3rd edition CBS Publisher and distributors, Delhi.
5. J. W. Brown and D. R. Sherbert, *Introductory Linear Algebra*, Bindle,Weber and Schmidt